Technical Information

Antifreeze and Anticorrosion Concentrate for Heating and Cooling Circuits.
Medium for Ground Source Heat Pump Systems

Characteristics of ***CoolForce 1*** Concentrate		
Appearance	lear, colourless liquid	
Boiling point	> 165 °C	ASTMD 1120
Pour point	< -15 °C	DIN ISO 3016
Density (20 °C)	1.120–1.125 g/cm	DIN 51757
Viscosity (20 °C)	24–28 mm ^{2} /s	DIN 51562
Refraction nD20	1.432–1.434	DIN 51423
pH value (20 °C)		
- concentrate	8.0–8.5	ASTMD 1287
- 33 vol. %	7.5–8.5	ASTM 1287
Water content	max. 4 %	DIN 51777
Flash poin	> 100 °	DIN 51758
Reserve alkalinity	> 10 ml 0.1 m HCl	ASTMD 1121

The above data represent average values that were valid when this Technical Information Bulletin went into print. They do not have the status of a product specification. Specified values are the subject of a special leaflet.

Properties

CoolForce 1 is a clear, colourless, and virtually odourless liquid based on ethylene glycol. The product is used as antifreeze / corrosion protection fluid and heat-transfer medium for heating, air conditioning and cooling circuits, as well as brine for heat pump systems.

CoolForce 1 is miscible with water in all proportions. ***CoolForce 1*** / water mixtures protect against frost at temperatures down to -50 °C, depending on their concentration, and lengthen the life of the installations that they protect. Water hardness constituents do not affect the performance of the product, and do not lead to precipitations from the heat-transfer fluid. Mixtures of ***CoolForce 1*** and water do not separate.
The corrosion inhibitors of ***CoolForce 1*** reliably protect the metals normally used in heating and cooling systems against corrosion, ageing and deposits over long periods even in mixed installations. ***CoolForce 1*** neither contains borax nor nitrites, phosphates, nor amines.

CoolForce 1 posseses excellent stability at high temperatures and prevents the formation of harmful deposits on hot metal surfaces (at temperatures of up to 200 °C) at watt densities as high as about 40W/cm ² . It thus helps to avoid overheating at heat-transfer surfaces and the formation of deposits in the circuit, and thus ensures consistently high thermal efficiency of the system.

Miscibility

CoolForce 1 is miscible with all commercial antifreezes based on ethylene glycol. If mixing of ***CoolForce 1*** with other products is intended, we recommend, however, to contact our department of application technique beforehand.

Application

CoolForce 1 is added to water (potable water quality, with a maximum chloride content of 100 mg/kg, or demineralised water) in concentrations of at least 20 percent by volume. The protection against frost deteriorates if the content of ***CoolForce 1*** exceeds 58 percent by volume.

Temperature stability

Sustained temperatures higher than 140 °C cause premature ageing of the heat-transfer fluid, but brief exposure to temperatures higher than 140 up to 200 °C can be tolerated if the liquid is subsequently cooled. At temperatures above 200 °C, the heat-transfer fluid commences to undergo chemical change, with the result that the dependability of the installation may be endangered. A blanket of nitrogen is recommended to lengthen the life of the heat-transfer fluid if the sustained operating temperature is higher than 110 °C.

Anticorrosion Effect

The following table demonstrates the anticorrosion effect of a 33 vol. % ***CoolForce 1*** / water mixture after a 14 days test at 88 °C under permanent aeration. Corrosiontest accordingly ASTMD 1384 (American Society for Testing and Materials).

PC-Cooling GmbH | Eichenallee 3 | D-24589 Nortorf | Fon: +49 (0) 4392 91 61 65 | Fax: +49 (0) 4392 9161 14

Material	Average change of weight
Copper (SF Cu)	– 0.1 g/m²
Soft solder (L Sn 30)	– 0.1 g/m²
Brass (MS 63)	± 0.0 g/m²
Steel (HI)	± 0.0 g/m²
Cast Iron (GG)	± 0.0 g/m²
Cast Aluminium (G-AlSi6Cu4)	– 0.4 g/m²

The outstanding anticorrosion properties of mixtures of ***CoolForce 1*** and water have also been demonstrated in high-temperature corrosion tests on cast iron GG 25 and cast aluminium G-AlSi10Mg subjected to the flow and heat-transfer conditions relating to watt densities up to 40 W/cm².

In order to maintain effective protection from corrosion, the concentration of ***CoolForce 1*** must not be allowed to fall below 20 percent by volume. This content corresponds to a freezing point of -9 °C. Concentrations lower than 20 percent by volume are insufficient and increase the risk of corrosion.

If ***CoolForce 1*** is run to existing installations in which only water has previously been circulated, it should be noted that the rust in these systems greatly increases the effective area of contact with the heat-transfer fluid.

It thus binds the corrosion inhibitors contained in ***CoolForce 1***, with the consequence that their effective concentration may be reduced to such an extent that the protection against corrosion is impaired. For this reason, the rust in these installations should be flushed out to the utmost extent before the filling. In particularly severe cases, pickling with subsequent neutralisation of the acid is recommended.

After they have been emptied, installations that have been run temporarily with ***CoolForce 1***must be thoroughly flushed several times to ensure that all residual traces of the product are removed, because any product residues may give rise to increased corrosion.

Compatibility with Sealing Materials ***CoolForce 1*** / water mixtures do not attack the sealings that are nor mally used in heating and cooling systems. The following table of sealants, elastomers and plastics that are resistant to ***CoolForce 1*** / water mixtures has been compiled from experimental results, experience, and from literature data:

Butyl rubber	IIR
Chloroprene	CR
Ethylene-propylene-diene-rubber	EPDM
Fluorocarbon elastomers	FPM
Natural rubber below 80 °C	NR
Nitrile rubber	NBR
Polyacetal	POM
Polyamides below 115 °C	PA
Polybutene	PB
Polyethylene, soft, hard	PE-LD/HD
Polyethylene, crosslinked	PE-X
Polypropylene	PP
Polytetrafluorethylene	PTFE
Polyvinylchloride, rigid	PVC h
Silicone rubber	Si
Styrene butadiene rubber below 100 °C	SBR
Unsaturated polyester resins	UP

Phenolic and urea resins, plasticized PVC, and polyurethane elastomers are not resistant.

An important point to note is that the performance of elastomers is not only governed by the properties of the rubber itself, e.g. EPDM, but also by the nature and amount of the constituent additives and the vulcanisation conditions. For this reason, it is recommended that their resistance to ***CoolForce 1*** / water mixtures is checked by performance tests before these elastomers are taken into use for the first time. This applies in particular to elastomers intended as membranes for expansion vessels as described in DIN EN 12828 and DIN 4807 Part 2, respectively.

The low surface tension of ***CoolForce 1*** / water mixtures in some cases may be the reason for leakage if the sealing strips have been produced from polytetrafluoroethylene (PTFE). Likewise, the addition of ***CoolForce 1*** in heating systems may allow latent leaks to be detected, because the resulting ***CoolForce 1*** / water mixture possesses higher wetting power than neat water.

If the leakage cannot be prevented by tightening the connections, the system must be drained. The sealings must then be replaced, and the connection must be rechecked to ensure that there is no leakage.

It is important that all connections with renewed sealings are retightened after the system has been restarted and brought to the maximum operating temperature.

The procedure for filling in stallations with forced circulation is to run in about two-thirds of the requisite amount of water first of all. ***CoolForce 1*** should then be added and the system topped up with the remainder of the water. The fluids become completely mixed after the circulation pump has been run for several hours. ***CoolForce 1*** and water must be completely mixed together before they are filled into systems with natural circulation.

Application Guidelines

In view of the specific properties of ***CoolForce 1*** , the following instructions must be observed to ensure long-term protection for the installations.

1.
Installations must be designed as closed circuits, as otherwise the contact with atmospheric oxygen will accelerate the cons umption of inhibitors.

2.
Flexible-membrane expansion tanks must con-form to DIN EN 12828 and DIN 4807 Part 2, resp.

3.
Silver or copper brazing solders are preferably to be used on joints. Fluxes used in combination with soft solder usually contain chlorides. Their residues must be removed from the system by thorough flushing. Otherwise, an increased content of chlorides in the heat-transfer fluid may lead for example to pitting corrosion on stainless steel.

4.
The systems must not be equipped with internally galvanised heat exchangers, tanks or pipes, because zinc can be detached by ethylene glycol / water mixtures.

5.
It must be ensured that no external voltages are applied between parts of the system that come into contact with ***CoolForce 1*** / water mixture, as otherwise corrosion may occur.

6.
The layout of the piping must ensure that the circulation of the heat-transfer fluid will not be disturbed by gas pockets or deposits.

7.
The fluid level must never be allowed to fall below the highest point in the system. A closed vessel fitted with a bleed valve must be provided at the highest point in the circuit in order to bleed gases from the system.

8.
If automatic bleed valvesare used, they must not allow subsequent suction of air into the system.

9.
Dirt and water must not be allowed to enter the installation or its components during assembly and before filling. After the assembly has been completed, the system should be flushed to remove e.g. swarf, fluxes, assembly aids and any other impurities. Following to the flushing process and the leak test, the circuit should be completely drained and then filled immediately with the ***CoolForce 1*** /water mixture, even if the plant is put into operation at a later date, in order to protect the circuit from corrosion.

10.
It must be ensured that no air pockets remain In the circuit after it has been filled. It is essential to eliminate any existing gas pockets, because their collapse following a temperature drop would give rise to a vacuum and thus cause air to be sucked into thesystem. Insufficient deaeration furthermore affects the heat transfer efficiency of the system.

11.
In-circuit filter elements must be cleaned within 14 days at the latest after the system was put into operation, in order to ensure that no obstruction to the fluid flow may occur due to deposits in any part of the installation.

12.
The concentration of ***CoolForce 1*** / water mixtures can be checked by measuring the fluid density with a hydrometer or an antifreeze tester suitable for ethylene glycol / water mixtures. An equally convenient and accurate way to determine the content of ***CoolForce 1*** is to measure the refractive index by a hand-held refractometer. The following table displays a summary of the freezing points, densities and the refractive indices of ***CoolForce 1*** / water mixtures.

CoolForce1 Concentrate	Freezing Point	Density at 20 °C	Refractive Index nD20
20 vol. %	-9.0 °C	1029 kg/m³	1.3545
25 vol. %	-12.3 °C	1037 kg/m³	1.3599
30 vol. %	-16.1 °C	1044 kg/m³	1.3653
35 vol. %	-20.4 °C	1052 kg/m³	1.3707
40 vol. %	-25.2 °C	1059 kg/m³	1.3762
45 vol. %	-30.8 °C	1066 kg/m³	1.3816
50 vol. %	-37.6 °C	1073 kg/m³	1.3868
55 vol. %	-45.4 °C	1079 kg/m³	1.3918
58 vol. %	-51.0 °C	1082 kg/m³	1.3947

13.
If losses occur due to evaporation, the system can be topped up with neutral potable or demineralised water. Fluid losses caused by leakage or removal from the system must be replaced by a mixture of ***CoolForce 1*** Concentrate and potable or demineralised water of equal content. In cases of doubt, the content of ***CoolForce 1*** must be determined via measurement of density or refractive index as described in section 13.

Storage Stability

CoolForce 1 has a shelf life of at least three years in airtight containers. It must not be stored in galvanised containers.

Delivery Form and Packaging
CoolForce 1 is available as a concentrate or ready-to-use according to customer's specification. It is supplied in road tankers, in 1000 litre IBCs, in 200 litre drums, and in 60, 30, 20 and 10 litre nonreturnable plastic cans.

Disposal

Spills of ***CoolForce 1*** must be taken up with an absorbent binder and disposed of in accordance with the regulations. For further information, please refer to the Safety Data Sheet.

Ecology

CoolForce 1 is classified in water hazard class 1, (low-rate endangering, Germany) according to german water hazard regulations (Verwaltungsvorschrift für wassergefährdende Stoffe of May 17, 1999). The product is readily biodegradable.

Safety

CoolForce 1 shall notbe used for installations, where penetration of the heat-transfer fluid into food processing or drinking water applications cannot be completely excluded.

Handling

The usual safety and industrial hygiene measures relating to chemicals must be observed in handling ***CoolForce 1***.
The information and instructions given in our Safety Data Sheet must be strictly observed.

Density of *CoolForce 1* / water mixtures [kg/m³]
as a function of temperature and concentration

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
120	970	975	982	991	999	1002	1003	1008	1012
110	978	983	990	998	1006	1010	1012	1017	1020
100	985	990	997	1005	1013	1017	1020	1025	1028
90	992	998	1004	1012	1019	1024	1027	1033	1036
80	998	1004	1011	1018	1025	1030	1035	1040	1043
70	1005	1011	1017	1024	1031	1037	1042	1047	1050
60	1010	1017	1024	1030	1037	1043	1048	1054	1057
50	1016	1022	1029	1036	1043	1049	1055	1060	1064
40	1021	1028	1035	1042	1049	1055	1061	1067	1070
30	1025	1032	1040	1047	1054	1060	1067	1073	1076
20	1029	1037	1044	1052	1059	1066	1072	1079	1083
10	1032	1040	1049	1056	1064	1071	1078	1085	1089
0	1035	1044	1052	1061	1068	1076	1083	1090	1094
-10	-	1046	1056	1064	1073	1081	1088	1096	1100
-20	-	-	-	1068	1077	1085	1094	1101	1106
-30	-	-	-	-	-	1090	1099	1107	1111
-40	-	-	-	-	-	-	-	1112	1117
-50	-	-	-	-	-	-	-	-	1122

Specific heat capacity of *CoolForce 1* / water mixtures [kJ/kg·K]
as a function of temperature and concentration

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
120	4.05	4.01	3.96	3.89	3.81	3.76	3.68	3.61	3.57
110	4.06	4.03	3.97	3.89	3.81	3.75	3.67	3.59	3.56
100	4.07	4.03	3.97	3.90	3.80	3.73	3.65	3.57	3.53
90	4.08	4.03	3.97	3.89	3.79	3.71	3.62	3.54	3.51
80	4.07	4.03	3.97	3.88	3.78	3.69	3.59	3.51	3.47
70	4.07	4.03	3.96	3.87	3.76	3.66	3.56	3.48	3.44
60	4.06	4.01	3.95	3.85	3.73	3.63	3.52	3.44	3.40
50	4.05	4.00	3.93	3.83	3.70	3.59	3.47	3.39	3.35
40	4.03	3.98	3.91	3.80	3.66	3.54	3.42	3.34	3.30
30	4.01	3.95	3.88	3.75	3.62	3.49	3.37	3.29	3.25
20	3.98	3.92	3.85	3.72	3.57	3.44	3.31	3.23	3.19
10	3.95	3.89	3.81	3.68	3.52	3.38	3.25	3.17	3.13
0	3.91	3.85	3.77	3.63	3.46	3.31	3.18	3.10	3.06
-10	-	3.81	3.72	3.57	3.40	3.24	3.11	3.03	2.99
-20	-	-	-	3.51	3.33	3.17	3.03	2.95	2.92
-30	-	-	-	-	-	3.08	2.95	2.87	2.84
-40	-	-	-	-	-	-	-	2.79	2.75
-50	-	-	-	-	-	-	-	-	2.67

Thermal conductivity of *CoolForce 1* / water mixtures [W/m·K]
as a function of temperature and concentration

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
120	0.624	0.596	0.569	0.535	0.504	0.479	0.454	0.430	0.416
110	0.612	0.585	0.559	0.527	0.496	0.472	0.448	0.425	0.411
100	0.601	0.575	0.549	0.518	0.489	0.465	0.442	0.419	0.406
90	0.590	0.564	0.539	0.509	0.481	0.458	0.436	0.414	0.401
80	0.579	0.553	0.529	0.500	0.474	0.451	0.429	0.409	0.397
70	0.567	0.543	0.518	0.492	0.466	0.444	0.423	0.403	0.392
60	0.556	0.532	0.508	0.483	0.459	0.437	0.417	0.398	0.387
50	0.545	0.521	0.498	0.474	0.451	0.430	0.410	0.392	0.382
40	0.534	0.510	0.488	0.465	0.444	0.423	0.404	0.387	0.377
30	0.522	0.500	0.478	0.57	0.436	0.416	0.398	0.382	0.372
20	0.511	0.489	0.467	0.448	0.429	0.410	0.391	0.376	0.368
10	0.500	0.478	0.457	0.439	0.421	0.403	0.385	0.371	0.363
0	0.489	0.468	0.447	0.430	0.414	0.396	0.379	0.366	0.358
-10	-	0.457	0.437	0.422	0.406	0.389	0.373	0.360	0.353
-20	-	-	-	0.413	0.399	0.382	0.366	0.355	0.348
-30	-	-	-	-	-	0.375	0..360	0.349	0.344
-40	-	-	-	-	-	-	-	0.344	0.339
-50	-	-	-	-	-	-	-	-	0.334

Kinematic viscosity of *CoolForce 1* / water mixtures [mm²/s]
as a function of temperature and concentration

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
120	0.42	0.45	0.49	0.52	0.57	0.61	0.62	0.67	0.71
110	0.45	0.49	0.53	0.57	0.63	0.67	0.68	0.73	0.77
100	0.48	0.52	0.57	0.61	0.67	0.73	0.76	0.81	0.84
90	0.52	0.57	0.62	0.66	0.72	0.80	0.87	0.91	0.93
80	0.58	0.63	0.68	0.73	0.79	0.91	1.01	1.05	1.06
70	0.65	0.71	0.78	0.84	0.91	1.05	1.20	1.25	1.26
60	0.76	0.83	0.91	0.99	1.08	1.26	1.45	1.53	1.55
50	0.91	1.00	1.11	1.21	1.34	1.56	1.81	1.94	2.00
40	1.12	1.24	1.38	1.54	1.73	2.00	2.30	2.55	2.70
30	1.41	1.58	1.77	2.01	2.31	2.64	3.02	3.49	3.79
20	1.83	2.07	2.34	2.72	3.19	3.62	4.11	4.96	5.57
10	2.45	2.39	3.18	3.80	4.58	5.16	5.85	7.37	8.54
0	3.35	3.87	4.46	5.49	6.85	7.75	8.84	11.6	13.7
-10	-	5.52	6.44	8.19	10.6	12.3	14.4	19.3	23.1
-20	-	-	-	12.5	17.1	21.1	26.2	34.7	41.0
-30	-	-	-	-	-	39.0	54.2	68.3	77.0
-40	-	-	-	-	-	-	-	150.0	153.0
-50	-	-	-	-	-	-	-	-	-

Prandtl numbers of *CoolForce 1* / water mixtures
as a function of temperature and concentration

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
120	2.65	2.98	3.35	3.72	4.30	4.81	5.01	5.63	6.13
110	2.91	3.30	3.75	4.20	4.84	5.39	5.63	6.30	6.81
100	3.20	3.63	4.12	4.62	5.27	5.96	6.40	7.07	7.51
90	3.57	4.04	4.57	5.10	5.77	6.68	7.41	8.04	8.41
80	4.05	4.59	5.18	5.97	6.49	7.64	8.73	9.37	9.70
70	4.71	5.35	6.05	6.73	7.56	9.00	10.5	11.2	11.6
60	5.61	6.41	7.27	8.13	9.14	10.9	12.9	13.9	14.4
50	6.86	7.88	8.99	10.2	11.5	13.7	16.1	17.8	18.7
40	8.61	10.0	11.4	13.1	15.0	17.6	20.7	23.5	25.3
30	11.1	12.9	14.9	17.4	20.2	23.5	27.3	32.3	35.6
20	14.7	17.2	20.1	23.8	28.1	32.3	37.3	45.9	52.4
10	19.4	23.6	27.8	33.6	40.7	46.4	53.2	68.3	80.2
0	27.8	33.2	39.6	49.0	61.2	69.8	80.4	106.9	128.5
-10	-	48.1	57.9	73.9	95.3	111.1	131.2	177.6	215.6
-20	-	-	-	114.0	153.4	189.6	236.7	317.7	380.2
-30	-	-	-	-	-	349.8	487.7	620.9	706.8
-40	-	-	-	-	-	-	-	1352	1389
-50	-	-	-	-	-	-	-	-	-

Vapour pressure of *CoolForce 1* / water mixtures [bar]
as a function of temperature and concentration

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
180	9.25	8.99	8.70	8.39	8.06	7.65	7.19	6.73	6.42
170	7.32	7.11	6.88	6.65	6.40	6.07	5.71	5.34	5.10
160	5.71	5.55	5.38	5.20	5.01	4.76	4.48	4.19	4.00
150	4.40	4.28	4.15	4.01	3.87	3.68	3.47	3.24	3.09
140	3.34	3.25	3.15	3.05	2.94	2.80	2.64	2.47	2.36
130	2.50	2.43	2.36	2.28	2.20	2.10	1.98	1.85	1.77
120	1.83	1.78	1.77	1.67	1.62	1.54	1.46	1.37	1.34
110	1.32	1.28	1.25	1.29	1.17	1.11	1.05	0.99	0.94
100	0.93	0.91	0.88	0.85	0.82	0.79	0.74	0.70	0.66
90	0.64	0.62	0.61	0.59	0.57	0.54	0.51	0.48	0.46
80	0.43	0.42	0.41	0.39	0.38	0.36	0.34	0.32	0.31
70	0.28	0.27	0.27	0.26	0.25	0.24	0.22	0.21	0.20
60	0.18	0.17	0.17	0.16	0.16	0.15	0.14	0.13	0.13
50	0.11	0.11	0.10	0.10	0.10	0.09	0.09	0.08	0.08
40	0.07	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05
30	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03

Cubic expansion coefficient of *CoolForce 1* / water mixtures [Ɣ10-5/K]
as a function of temperature and concentration

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
120	79	80	79	73	67	75	86	85	83
110	76	77	76	71	66	72	81	81	80
100	72	73	72	68	64	69	77	79	76
90	68	70	69	66	62	66	73	73	73
80	64	66	65	63	60	64	69	70	70
70	60	62	62	60	58	61	65	67	67
60	56	57	58	57	56	59	62	64	64
50	51	53	54	54	54	56	59	61	62
40	46	48	50	51	52	54	57	59	60
30	40	44	46	48	49	51	54	56	58
20	35	39	42	45	47	49	52	55	56
10	29	34	38	42	45	47	50	53	54
0	22	28	34	38	42	45	49	51	53
-10	-	23	29	35	39	44	47	50	52
-20	-	-	-	31	37	42	46	49	51
-30	-	-	-	-	-	40	46	49	50
-40	-	-	-	-	-	-	-	48	50
-50	-	-	-	-	-	-	-	-	49

Example for calculating the volume expansion:
What would be the increase in volume (in litres) if V_0 = 80 litres of a 30 % vol. ***CoolForce 1*** / water mixture will be heated from t_0= -10 °C to t_1= +90 °C ?

$åt = t_1 - t_0 = +90 - (-10) = 100$ °C, $t_{average} = t0 + åt/2 = -10 + 100/2 = +40$ °C
$ß_{average}$ (from table for 30 % vol.) = $50 \cdot 10^{-5}$
$åV = ß_{average} \cdot åt \cdot V0 = 50 \cdot 10^{-5} \cdot 100 \cdot 80 = 4.0$ litres increase in volume.

Relative pressure drop factor of *CoolForce 1* / water mixtures
in comparison with water at 10 °C, turbulent pipe flow (approximate values)

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
100	0.77	0.78	0.80	0.81	0.83	0.85	0.87	0.88	0.90
90	0.79	0.81	0.83	0.84	0.86	0.89	0.91	0.93	0.94
80	0.82	0.84	0.86	0.88	0.90	0.93	0.95	0.97	0.99
70	0.85	0.88	0.90	0.92	0.94	0.97	1.00	1.02	1.04
60	0.88	0.91	0.94	0.96	0.99	1.02	1.05	1.08	1.10
50	0.91	0.95	0.99	1.01	1.04	1.07	1.10	1.14	1.18
40	0.96	1.01	1.05	1.07	1.10	1.14	1.17	1.22	1.27
30	1.01	1.06	1.11	1.14	1.18	1.22	1.26	1.32	1.37
20	1.08	1.14	1.19	1.23	1.28	1.32	1.35	1.42	1.49
10	1.17	1.23	1.29	1.33	1.38	1.42	1.46	1.55	1.64
0	1.29	1.35	1.40	1.45	1.50	1.56	1.61	1.71	1.80
-10	-	1.50	1.59	1.63	1.68	1.74	1.80	1.93	2.05
-20	-	-	-	1.85	1.92	1.99	2.06	2.21	2.35

Antifreeze effect of *CoolForce 1* / water mixtures

The freezing point, colloquially called 'antifreeze', is a measure for the freezing point depression effect of antifreeze fluids. When a given ***CoolForce 1*** / water mixture is cooled down, the freezing point is the temperature at which initial ice crystals begin to form.The resulting ice slurry does not possess any expansive force. Further reduction intemperature causes further thickening of the ice slurry until it solidifies at the pour point. Only below this temperature, there is danger of bursting for the installation. The arithmetic mean from freezing point and pour point is referred to as frost protection. The following table displays the freezing points, frost protection and pour points of ***CoolForce 1*** / water mixtures as a function of the concentration:

CoolForce1 Concentrate	Freezing Point (acc. ASTM D 1177)	Frost protection (calculated)	Pour point (acc. DIN 51583)
20 vol. %	-9.0 °C	-11.0 °C	-13.0 °C
25 vol. %	-12.3 °C	-14.8 °C	-17.3 °C
30 vol. %	-16.1 °C	-19.1 °C	-22.0 °C
35 vol. %	-20.4 °C	-23.7 °C	-26.9 °C
40 vol. %	-25.2 °C	-28.6 °C	-32.0 °C
45 vol. %	-30.8 °C	-33.4 °C	-37.2 °C
50 vol. %	-37.6 °C	-40.7 °C	-45.2 °C
55 vol. %	-45.4 °C	< -50 °C	< -50 °C
58 vol. %	-51.0 °C	< -50 °C	< -50 °C

Note

The information submitted in this publication is based on our current knowledge and experience. In view of the many factors that may affect processing and application these data do not relieveprocessors of the responsibility of carrying out their own tests and experiments, neither do they imply any legally binding assurance of certain properties or of suitability for a specific purpose. It is the responsibility ofthose to whom we supply our products to ensure that any proprietary rights and existing laws and legislations are observed.